Theoretical Considerations on the Elasticity of Plasticized Polyvinyl Chloride (PVC)

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Kanamaru measured the fluidities and yield-points of polyvinylbutyral which was plasticized with dibutyl phthalate. When ln η are plotted against ln f. however, they form a line which has a different slope from ours. The reason for this difference may be due to the different ranges of viscosity for the two cases, that is, for the rubber 10^6–10^{11} poises and for the latter 10^{10}–10^{13} poises. We are going to investigate the relation by either elevating or lowering the viscosity by the addition of fillers and plasticizers respectively.

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24. Theoretical Considerations on the Elasticity of Plasticized Polyvinyl Chloride (PVC).

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The author regards the elasticity G of plasticized PVC as the visco-elasticity. Kuhn gives a formula for the viscoelasticity of polymer, which consists of k units as follows,

$$G=G_1e^{-t/\lambda_1}+G_2e^{-t/\lambda_2}+\dots\dots\dots+G_ke^{-t/\lambda_k}$$

where $G_1\dots\dots G_k$, $\lambda\dots\dots\lambda_k$ are elasticities and relaxation times of units respectively and t is time of observation. The author proposes thereof a simplified average formula as follows.

$$G=G_Le^{-t/\bar{\lambda}}$$

$\bar{\lambda}$ is an average relaxation time and is indicated as follows.

$$\bar{\lambda}=\bar{A}e^{\bar{E}/RT}$$

where $\bar{E}$ and $\bar{A}$ are the average value of activation energy and entropy of segments respectively. From this formula, the following empirical formula after Dienes will be derived.

$$\frac{lnG_L-lnG}{lnG-lnG_H}=\left(\frac{R}{E}\right)^n T^n=BT^n$$

where G_L and G_H are the elasticity at the temperature low and high respectively, while B and n are both constants.

Platicizer added to the polymer lowers the viscosity and the elasticity of the system. Platicizer of smaller λ shows the higher softening effect and gives greater temperature coefficient of elasticity.

According to the author's theory the plasticizer of smaller E/λ and also smaller λ shows the superior plasticity.

Thus, from the conclusion in consideration of the weight average of λ between plasticizer (1) and polymer (2), was obtained the following equation which indicates that log G decreases linearly in accordance with plasticizer content W_1.

$$lnG\cong lnG_L[ln\lambda_2-W_1(ln\lambda_2-ln\lambda_1)]+C$$

Finally, provided that the equation, $ln\lambda=AlnM+B$, is given, where M is molecular weight of polymer and A, B are constants, the following linear relation between lnG and M is obtained.

$$lnG\cong lnG_L[AlnM-lnt]+C$$